

## Description

Modular machine and corresponding method for dynamically configuring the topology of said machine

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The present invention relates to a method for dynamically configuring a topology of a modular machine whose modules are connected to one another and to a control device via a communications network. The present invention additionally  
10 relates to a modular machine of this kind.

A modular machine for automated production processes is usually configured, in terms of its mode of operation, for the automation task to be solved. This means that, among other  
15 things, the individual modules of the machine are assigned corresponding tasks. This configuring is performed using an engineering system without taking the communications network topology of the machine modules into account. To ensure that the individual machine modules can also intercommunicate to  
20 perform their function, the communications topology is also determined at the engineering stage and a corresponding communications configuration is defined. This communications configuration is loaded into the automation system which constitutes the control device of the modular machine.

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If the configuration of the machine, i.e. its modular structure, is then changed, this also generally results in a changed communications configuration. If a rigid topological communications configuration is used, this means than any  
30 successor of a communications partner (e.g. a replaced module) for which the address has been changed can no longer be communicated with, as the system no longer knows how it can be reached if necessary via other communications partners. The

same problem arises if the connection of a communications partner to the communications network of a modular machine is re-arranged. Again the system (control device and other machine modules) no longer knows how the communications partner can be reached in the topology.

To solve this problem, in present systems the configuration, including the communications configuration, matching a changed topological machine structure is therefore loaded into the corresponding automation system and all the machine modules. However, this is a relatively complex and/or costly process and involves interrupting machine operation.

The object of the present invention is therefore to make it easier to reconfigure a modular machine.

This object is achieved by a method for dynamically configuring a modular machine whose constituent modules are connected to one another and to a control device via a communications network, by determining the communications partners in the communications network by means of one of the communications partners while the machine is in operation, generating an appropriate communications configuration by means of one of the communications partners and activating the generated communications configuration during runtime of the machine.

There is additionally provided according to the present invention a modular machine having a plurality of machine modules, a control device for controlling the machine modules in an open- or closed-loop manner, and a communications network with which the control device and the machine modules are interconnected for communication, the communications

partners being ascertainable in the communications network using one of the plurality of machine modules and/or the control device and an appropriate communications configuration being generatable and activatable during the machine runtime.

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The inventive dynamic configuring of the topology of the communications network of the modular machine has the advantage that, when the communications topology is reconfigured, machine operation does not need to be interrupted and it is possible for the communications to be configured during the runtime of the machine.

In a preferred application, the modular machine according to the invention is incorporated in a production process, and generation of the communications configuration is initiated by an internal or external process event. A process event of this type can be an alarm signaling a new communications partner, an operator input or a change of a communications partner. This means that it is possible according to the "plug-and-play" philosophy for a machine module to be replaced or plugged into another socket during the runtime of the machine.

The generated communications configuration is preferably stored centrally in a server connected via the communications network or non-centrally in one of the communications partners. This means that the communications configuration is always accessible for reconfiguring.

The communications network can comprise at least one subnetwork with which a second machine module can be connected to a first machine module for communication, so that the second machine module is connected indirectly to the communications network via the first machine module. This

means that the communications configuration also includes subnetworks which are not connected directly to the main network. In this way the communications partners of the subnetworks can be also detected for automatic, dynamic  
5 configuring.

A preferred method for putting a modular machine into service therefore begins with the step of configuring the interaction of the machine modules, prior to the startup stage of the  
10 modular machine, by means of an engineering system for an automation task to be solved without taking the communications topology of the individual machine modules into account, followed by the step of dynamically configuring the communications network with which the machine modules are  
15 interconnected, according to the above described configuration method. This considerably simplifies the engineering process prior to the machine startup stage.

The present invention will now be explained in greater detail  
20 with reference to the accompanying drawing which schematically illustrates the communications topology of a modular machine.

The exemplary embodiment described in greater detail below is a preferred embodiment of the present invention.

25 A flexible, modular machine typically consists of machine modules M1 to M6 as shown in the figure. The machine modules M1 to M3 are connected to a communications network KN. The possible separation between the machine modules and the  
30 communications network KN is indicated in the figure by a dotted line.

The machine modules M1 and M4 are interconnected via a communications subnetwork S1, the machine modules M2 and M5 via a communications subnetwork S2 and the machine modules M3 and M6 by a communications subnetwork S3. The subnetworks S1 to S3 are therefore connected only indirectly to the communications network KN via the relevant machine modules M1 to M3. Obviously the respective subnetworks S1 to S3 can each contain any number of further subnetworks. It is likewise conceivable for further modules to be connected to the modules M4 to M6 via additional subnetworks.

The modules M1 to M6 are controlled by an automation system AS via the communications network KN / S1 to S3. The automation system AS is connected for its part to an engineering system ES. A machine configuration created using the engineering system ES can therefore be stored in the automation system AS.

According to the invention, one of the communications partners of the communications network KN, in this case the machine module M1 is selected by way of example, is used to determine the communications partners connected to the communications network KN including its subnetworks S1 to S3 and to generate a corresponding communications configuration or parameterization. This configuration is then stored in the machine module M1 and activated during the runtime of the machine. It is therefore possible for one of the machine modules M1 to M6 to be replaced or replugged at any time without needing to stop the machine. The machine module M1 determines the communications configuration dynamically, e.g. by analyzing adjacencies between the communications partners or signal timings. In the present case, not only the modules M1 to M6 but also the automation system AS and the engineering system ES are regarded as communications partners.

However, the communications topology can also be determined alternatively or simultaneously by the automation system AS or another communications partner and a corresponding communications configuration generated and activated. A special server in which the communications configuration is stored and made available can likewise be connected to the communications network.

- 10 The configuring procedure is initiated e.g. by an operator input in the engineering system ES or plugging of a module M1 to M6 into the communications network KN or the corresponding subnetwork S1 to S3 or a process event, etc. Such an event triggers not only the automatic generation of the
- 15 communications configuration but also, optionally, automatic activation of said communications configuration.

In order to organize the configuring procedure efficiently, only the changing communications partners are redrawn.

- 20 Communications relationships of non-changing communications partners are retained. The only requirement for successful configuring is that at the time of communications configuring all the possible communications partners are known.
- 25 The dynamic configuring described in the selected example enables modular machines to be supported in respect of a flexible topological machine structure and any change to said machine structure at runtime.